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COTTON AND WOOL BLENDS- A REVIEW

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ABSTRACT

Cotton/wool blended fabrics are growing in popularity, due to increased consumer demand for styling, comfort and for natural fibers. There is a resurgence of interest in blending these two natural fibers throughout the developed world, because they are perfect complements of each other. When blending of cotton and wool takes place, the strengths of one fiber tempers the weaknesses of the other. The popularity of these blends is due to their light weight, good strength, drapability, easy washability together with low cost. Blended worsted yarns containing approximately equal proportions of wool and cotton have been long established in knit wear, dress wear, under wear, children's clothing, light weight shirting's, pajamas clothes and blankets. As morphology, physical and chemical structure of both these fibers differs, lots of work has been done by researchers on spinning, finishing and dyeing of this blend. Present paper reviews aforementioned aspects related to cots wool blend.

KEYWORDS: Cots Wool, Spinning, Dyeing, Finishing

INTRODUCTION

Clothing has been of great importance to man and ranks second only to food in their usefulness. The variety of natural and man-made fibres available today, offers a wide selection to be used in clothing. Globally natural fibres contribute about 48% to the fibre basket with 38% from cotton, 8% from bast and allied fibres and 2% from wool and silk fibres. Man's desire, to produce perfect fabrics resulted in the production of blended fabrics.

Blending of Fibres

There is no perfect fiber. All fibers have good, fair and poor characteristics. Blending enables the technician to combine fibers so that the good qualities are emphasized and poor qualities are minimized. Usually different natural and synthetic fibers are blended together to achieve better qualities of both natural and synthetic materials. (Textilelearner.blogstop.com). A blend is an intimate mixture of fibers of different composition, length, diameter and color spun together into a yarn. The accepted definition of a blend, as stated by ASTM, is a single yarn spun from a blend or mixture of different fiber species. Blending is a complicated and expensive process, but it makes it possible to build in a combination of properties that are permanent.

Blended fabrics were very hard to produce at first, that`s why they were meant for kings. But then industrial revolution and modern achievement of technology made the process of blending much cheaper, and nowadays such fabrics are available for everyone.

Growing importance of fiber blends in apparels is because of many reasons such as expensive fibers can be extended by blending them with more plentiful fibers, produce fabrics with a better combination of performance characteristics in the product. This is perhaps the most important reason for blending. In end uses where durability is very important, nylon or polyester blended with cotton or wool provide strength and resistance to abrasion while the wool or cotton look is maintained.

But there are also other purposes of blending. Not only blends are used for better serviceability of fabrics but they are also used for improved appearance and hand.For example, different sorts of natural fibers can be mixed to improve aesthetic of final fabric. Such purposes of blending were met by a man even at the beginning of fabrics weaving. These decorative purposes of blending lead to a very interesting combination and appearance of very beautiful materials. A small amount of specialty wool may be used to give a buttery or slick hand to wool fabrics. Fabrics with different shrinkage properties are blended to produce bulky and lofty fabrics or fur-like fabrics, obtain cross dyed effects or create new color effects, when fibers with unlike dye affinity are blended together and then piece dyed to improve spinning, weaving finishing efficiency for uniformity of product as with self blends of natural fibers to improve uniformity.

Technically the process of blending is not that simple, first of all, the filaments are not suited for blending. Longer filaments are much harder to handle while blending, so they are not used. Usually these longer filaments are cut into shorter filaments that are called staple fibers. On the other hand, many natural fibers (wool, for example) are already short and can be used for blending as they are. Another important thing is the sort of fibers for blending. As long as properties of different fibers vary greatly, not all combinations of fibers are possible.

Wool Cotton Blended Products

Cotton/wool blended fabrics are growing in popularity, due to increased consumer demand for styling, comfort andfor natural fibers. There is a resurgence of interest in blending these two natural fibers throughout the developed world, where such blends in garments traditionally made from cotton are seen as conferring desirability and exclusivity in high quality dress wear and shirting fabrics.

Wool is blended with cotton in various ratios. In cotswool fabric, wool fiber provides warmth property due to its scaly surface, as air entrapped in the scales acts as an insulator. In addition, wool contributes resiliency, abrasion resistance and good drapability. Cotton adds strength and reduces the cost of the yarn and fabric. Both fibers are absorbent and can be blended to make a comfortable, durable fabric. Wool: cotton blends for apparel fabrics combine comfort with exceptional aesthetic appeal. The popularity of these blends is due to their light weight, good strength, drapability, easy washability together with low cost.

Blended worsted yarns containing approximately equal proportions of wool and cotton have been long established in knit wear, dress wear, under wear, children's clothing, light weight shirting's, pajamas clothes and blankets. The original Viyella shirt fabric was a wool/cotton blend. The cotton/Merino blends are used for light weight sweaters.

Palmieri (1986) stated that wool /cotton blend fabrics or cotswoolare not expected to replace all wool apparel, but rather to extend the use of wool into apparel in a non-traditional niche such as well with sunbelt customer. In Indian climate conditions, during pre and post winter seasons, use of cotton / wool (cots wool) blended fabric is very popular for apparel purpose.

Spinning of Wool-Cotton Blends

The process of spinning of cotton and wool fibres is quite different. They require altogether different types of machinery and processing methods. Production of these fabrics in appropriate fabric densities requires total engineering beginning with the wool and cotton fiber selection, the wool preparation, cutting, blending, yarn manufacturing, fabric construction, dyeing and finishing.

During the last few years the spinning of cotton/wool blends has received renewed attention. (SAWTRI Technical report, No. 298- May, 1976).Blending is done in initial opening stage of the blow room operation. The blending can also be done in the carding stage, drawing or roving stage.

Various researches in CIRCOT and CSWRI have been conducted to explore the possibilities of blending Avivastra wool with cotton and producing good quality yarns adopting commercial cotton spinning systems.

Lupoton and Khan (1984) mixed 50.80 mm long cut top wool of two grades (62s and 8s) with cotton and polyester fibers at varying blend levels. Total 13 yarns of 6.9 tex, 16/1 Nc were prepared on ring spinning system using the short- staple system of mechanical processing. Crepe fabrics were manufactured from each yarn. **(**http://www.researchgate.net/publication/249783480_Production_and_Performance_of_Wool_Blend_Fabrics_Composed_of_Yarns Spun on the Cotton System)

Tokumari(1975) also reported results of an investigation of the spinning of pure wool on the cotton system. In this particular investigation the Heltra Short Breaker was used. This machine is capable of reducing the fiber length of natural fibers, such as wool and mohair, to lengths suitable for spinning on the cotton system. This unit is fed with fibers in the form of top or sliver and the fibers are stretch – broken into staple lengths suitable for spinning on the cotton system.

Chemical Finishing of Wool-Cotton Blends

Most fabrics are routinely subjected to one or more general finishing processes. General finishes are applied by mechanical or chemical means and may or may not affect fabric performance, care, and use. The order of application of finishes varies with fiber type, manufacturing process, and economic factors. The sequence typically used in the industry includes cleaning the cloth prior to subsequent finishing, shaping, sizing, or preparing cloth for further finishing and improving texture, hand, and/or appearance.

Finishing of cotton and wool fibers are quite different. They require altogether different types of machinery and processing methods. Studies conducted by Cotton Incorporation determined that an 80/20 cotton/wool blend was the best overall to achieve a washable product without the use of chlorinated wool. Both cut and stretch broken wool in grades 56's, 64's, and 70's were evaluated. Draw blending and intimate blending provided different fabric properties, yet both proved satisfactory in spinning, knitting, weaving, dyeing, and finishing. Since cotton is normally processed under alkaline conditions, while wool is normally processed under acidic conditions, preparation and dyeing of blends of these fibers involve unique processing considerations. Techniques for preparing, bleaching, and dyeing to achieve heathers, cross dyes and union shades have been developed that cause minimum wool degradation. Finishing techniques for this blend have been evaluated and formulations found which provide true performance products that are fully washable with easy care and low shrinkage properties.

A single-stage process for anionic dyeing and easy-care finishing of wool/viscose (60/40) and cotton/wool (70/30) blended fabrics was developed by Ibrahim et al (2007). They found following optimum conditions for maximizing dyeability and achieving high resiliency: Fixapret® ECO (50 g/L), triethanolamine hydrochloride (20 g/L), ammonium per sulphate (7.5 g/L) at 160°C for 3 min. It was also observed that the extent of improvement in both the depth of shade and easy-care properties is determined by the nature of substrate and follows the descending order: wool/viscose > cotton/wool. On the other hand, the extent of dye fixation and the change in fastness properties of the obtained dyeing are determined by class ofdyestuff.(http://www.tandfonline.com/doi/abs/10.1080/03602550600553572#.VcNR4BEVjIV)

Ibrahim et al (2008) made an endeavour to enhance the performance properties of easy-care finished cellulose/wool blends. To achieve the aim, cotton/wool and viscose/wool blended fabrics were finished in the presence of certain anionic, cationic, polyol, or softening agents independently. Properties of finished fabrics viz. nitrogen and/or carboxyl contents, resiliency, hydrophilicity, dye ability with proper class of dyestuff (anionic or basic), as well as oil stain release rating were evaluated to determine the optimal finishing formulations for attaining better performance properties. It was observed that inclusion of any of the anionic additives, i.e., citric acid, tartaric acid, lactic acid, and aspartic acid, or polyol additives, i.e., β-cyclodextrin, PEG-600, and CMC-30, in the finishing formulation brings about an improvement in the above properties. The extent of improvement is governed by both the nature of the additives and the substrate components. The enhancement in fabric properties by adding any of the nitrogenous additives to the finishing bath follows the descending order: Chitosan® >Quat®-188 > choline chloride > triethanolamine hydrochloride; and addition of any of the softeners to the finishing bath results in an improvement in nitrogen content and fabric resiliency, and follows the decreasing order: Siligen® WW > Syltrit®30 >Leomin® NI-ET > none, along with a decrease in finished fabric hydrophilicity. (http://www.tandfonline.com/doi/pdf/10.1080/03602550701869943#.vcnr2hevjiv)

In another study the possibility of enhancing easy care properties as well as imparting antibacterial properties to cotton/wool and viscose/wool blends were studied by Ibrahim et al (2008). Crosslinking in presence of certain additives (i.e., carboxylic acids, N-containing additives, polyols) as well as softening agents, followed by subsequent treatment with $ZnCl_2$ solution was studied. It was found that the improvement in carboxyl content and/or nitrogen content as well as the degree of crosslinking is governed by the type of the included additive (e.g., chemical composition, functionality, reactivity, mode of interaction, location and extent of distribution) along with the nature of substrate (e.g., chemical nature, active sites, crystalline/amorphous ratio, affinity for the used reactants, extent of modification). The degree of antibacterial activity is confirmed against gram positive and gram negative bacteria. After 15 laundering cycles, the fabric samples containing Zn exhibit prominent antibacterial functionality irrespective of the used additives. (http://www.tandfonline.com/doi/full/10.1080/15440470802457193#.VcNUqBEVjIV)

A research was conducted by Ibrahim et al (2013) for modifying the pigment print paste to produce pigment prints on cotton/wool and viscose/wool in one step process. Chitosan (2.5g/kg), Aloe vera (10g/kg), triclosan (10g/kg), TiO_2-nanoparticles (TiO2-NP's, 10g/kg), silicon micro-emulsion (20g/kg) or a water/oil-repellent agent (40g/kg) were used individually. The properties such as antibacterial, antibacterial/UV-protection, soft-handle and water/oil-repellency together with the change in the printing properties were evaluated. It was reported that a wide-range of functional properties together with the depth of the obtained pigment prints can be obtained which were were maintained over 80% even after 15 consecutive laundering cycles. The extent of retention in functional and pigment printing properties is

influenced by the type of functional additive as well as the kind of substrate. (http://www.sciencedirect.com/science/article/pii/S0144861713003342?np=y)

Ibrahim et al (2007) developed a one-bath functional finishing process for imparting durable multifunctional properties such as easy care, soft-hand, antibacterial and/or ultra violet (UV) protection to cotton/wool and viscose/wool blends using diverse finishing combinations and formulations. Finishing agents such as reactant resin, silicon softeners, 4-hydroxybenzophenone, triclosan, and pigment colorant were selected using magnesium chloride/citric acid as a mixed catalyst and the pad-dry microwave fixation technique. The results revealed that improvement in the functional properties are governed by type of the finished substrate as well as nature and concentration of finishing agents. The finished fabrics retained high level of functional properties even after 15 repeated laundering. (http://www.researchgate.net/publication/233212252_UVProtective_Finishing_of_CelluloseWool_Blended_Fabrics)

Dyeing of Cotton-Wool Blend

Dyeing a cotton/wool blend is difficult because the two fibers have different chemical makeups. Wool, which is sheep hair, is made of animal proteins, while cotton is made of plant cellulose—the main part of a plant’s cell wall. Thus the dyers have to face in-numerable problems in connection with the preparation and dyeing of such blended materials.

Dyeing may be done in loose state and then fibres mixed before spinning into yarn. Also yarn, may be dyed in different shades separately and then twisted to produce fancy yarn in two- fold. The warp and weft of a fabric may be of different fibres. Dyeing is cheaper in loose form but it is safer to dye in piece form as far as unions are concerned, specially because the material can be stocked in grey and the dyed on orders received whereas when loose material is dyed and kept in stock, it need a large quantity to be stocked.

There are mainly three methods to dye blends of cotton and wool whether in loose, yarn or piece form:

- Dyeing in a single bath (one bath)
- One bath at two dye stages
- Two bath (double bath)

One dye bath process is the most economical but this would depend upon the type of union. However, temperature and pH need to be controlled critically as these have vital bearing on the pick-up of different types of fibres when dyed with the same dye stuff. By the two other methods, either the dyeing is done in the same bath at two stages or dyed separately using two baths. At times staining of other fiber takes place and before dyeing the other fiber in separate bath some cleaning operation may be necessary to remove the unstained portion to get pure and bright shades. Normally, when wool and cotton are blended together, two separate dye baths are required because the wool takes up most of the dye.

There are three possible ways of dyeing mixture of protein and cellulosic fibres.

- Dyeing the protein or cellulosic fibre and leaving the other white. In union materials this is often referred to as dyeing “wool way” or “cotton way”.
- Dyeing both fibres the same colour, known as solid colour.
- Dyeing the two fibres different shades, a procedure to which the term “cross- dyeing” is applied.

Dyeing “wool way” - To dye the wool in a union without staining the cellulose, which may be either regenerated or natural, is comparatively simple. It is not a very common for the wool to be dyed and the cellulose to be left white, but quite a general practice to incorporate a pattern constructed out of cellulosic yarns dyed in fast colours with an undyed wool background. The problem of dyeing such materials “wool way” is the same as leaving the other component white, because a non- staining method must be used. When wash fastness is not important the molecularly dispersed acid dye can be used. Better resistance to washing and non-staining of cellulosic is obtained with premetallized dyes but they lack brightness of shade.

Dyeing “cotton way”-Most of the direct dyes will stain wool either heavily or to a slight extent in a neutral dyebath, and if acid be present the protein fibre will develop strong affinity for them. It is, therefore,by no means easy to dye “cotton way”. The pH of dye bath is most important, slight alkalinity reserving the wool and the slightest trace of acid having the reverse effect. The usual method of dyeing cotton with minimum staining on wool is to maintain the temperature between 40 to 60 and add 1 % sodium carbonate (w/w).

Solid shade dyeing – Cotton-wool blend is commonly dyed in solid shade. It can be done in two stages or one stage.

The double bath method: - By this method, wool portion is first dyed with acid dyes. The acid is thoroughly rinsed out, using a little ammonia to assist. Then in a separate bath cotton portion is dyed with suitable direct dyes at a lower temperature at which direct dyes do not come up on wool especially when wool has retained some acid from the previous dyeing with acid dyes.

The one bath process: -There are a great number of union dyes available which are usually mixture of neutral dyeing acid dyes and a direct dye having little affinity for wool,which can be used in the same bath with careful manipulation of temperature and use of assistants. Alternatively, a neutral dyeing direct dye can be used, both of which stain the two fibres to a minimum degree. In one- bath process, the material already wet from the scouring process, may be entered at 50ºC. Common salt or glauber´s salt (10-15%) and 5% ammonium sulphate are added to neutralize the residual alkali from the scouring treatment to get a pH of 6.5-7.5 and worked for 10-15 minutes. Then the well dissolved dye is added and the temperature is raised to 90 ºC in 30 min. Dyeing is continued for 1 hour. If the cotton portion appears lighter, than the temperature is allowed to drop down to 50-60 ºC by turning off the steam as at lower temperature most of the direct dye will come up on cotton portion.

For two colour effects, cotton is usually dyed in warp form before weaving and then cross dyeing the woollen portion (weft). Alternately the two fibres are separately dyed in loose form. For two colour effects, wool portion is first dyed with acid dyes and then the cotton portion is dyed with direct dyes at the low temperature when hardly any direct dye is picked by specially when dyed in neutral or slightly alkaline bath.

According to Beech, The Dyes Now Under Consideration May be Conveniently Classed into Five Groups:-

- Those dyes which dye the cotton and wool from the same bath to the same shade, or nearly so. Among these isThioflavine S, Diamine fast yellow B etc.
- Dyes which dye the cotton a deeper shade than wool. The following belong to this group: Diamine fast yellow A, Diamine oranges G and D etc.

- Dyes which dye a wool a deeper shade than the cotton. The dyes in this group are not numerous. They are Diamine gold, Diamine scarlet B etc.
- Dyes which produce different shades on the two fibres. Diamine brown G, Diamine blue 3 etc.

Cardamone and Marmer's simple approach is to reverse the chemical charge of cotton from negative to positive before dyeing; wool is already positive. To do this, they use cationic fixatives— positively charged ions—which are typically used after cotton is dyed to help it keep its color. Applying the fixatives before dyeing gives both fiber components of the fabric a positive charge. Since the dye is negatively charged—and opposites attract—the cotton and wool dye to a uniform shade because the dye is attracted equally to both fibers. This union-dyeing process uses one dye in one bath, under one set of conditions.

The ERRC scientists also use another method that helps make dyeing wool/cotton blends possible—a durable-press finishing resin. The resin treatment was originally developed by chemists at the ARS Southern Regional Research Center (SRRC) in New Orleans, Louisiana, to prevent wrinkling in 100-percent cotton. SRRC scientists further developed the technology to increase cotton's dyeability. SRRC chemist Eugene Blanchard collaborated with ERRC scientists on using the durable-press finishing resin treatment for cotton/wool blends. Cardamone says resin treatments, which are alternatives to cationic fixatives, are important for good colorfastness in laundering. Colorfastness is a textile industry standard that determines how stable the color is in a garment. Good colorfastness means the garment won't fade after one washing. Resin pretreatment is best for garments that require excellent colorfastness. Cationic fixatives could be used for outerwear garments where colorfastness to washing is moderate but colorfastness to dry cleaning is high, both pretreatment systems will effectively lead to union dyeing of wool/cotton blends, but the treatment should be selected to accommodate the anticipated end use. Through a cooperative research and development agreement between ERRC researchers and chemical specialties manufacturer Hercules, Incorporated, other pretreatment systems are being investigated. Applied commercially, these technologies may cut textile dyeing costs—savings that can be passed on to consumers seeking versatile garments for spring and fall.

Dyeing with reactive dye- extremely good fastness on cellulosic component can be obtained with the reactive dye. The cold dyeing methods are preferable because the conditions of alkalinity and temperature necessary to fix the high temperature reactive dyestuffs would be harmful to the wool. When Procion dyes are used in cold condition, the protein portion is left practically unstained, less it has been chlorinated previously, and must be brought up to shade with neutral dyeing acid dye.

El- Shishtawy et al (2005) carried out union dyeing of cotton/wool blend with hetero bi-functional reactive dyes, namely CI Reactive Yellow 145, CI Reactive Red 194, and CI Reactive Red 195 using one-bath and two-bath dyeing processes. The results obtained were compared with those obtained by conventional two-bath dyeing process. Factors affecting the dyeability, such as the amount of sodium edate, sodium sulphate, temperature and dye concentration were investigated. The dyed fabrics were evaluated with respect to the dye exhaustion and fixation, levelling and the fastness properties. Excellent to good fastness was obtained for all samples irrespective of the dyeing method. (http://www.sciencedirect.com/science/article/pii/S0143720805002500)

Garment dyeing: - It is much more difficult than union dyeing on the long run in view of the fact that garments suffer long exposure to sun and weather as a result of which faded portions have to be evenly covered up. The back of the

garments, outer portions of the sleeves, the collar portion which is exposed, get faded badly becoming not only lighter but also there is a change in tone of the original colour. Besides these there is a physical and chemical change on these portions pick- up more dye than the less exposed portions, and there are also dyes which come up lighter on the exposed portion. All these difficulties demand an expert to select the proper type of dyes of re- dyeing an old garment.More often than not, the faded portions dye deeper with most acid dyes. In a wool/cotton union, the faded portion can be covered up with acid dyes, but the cotton portion picks up more dye at lower temperature. The best procedure is to do away with acid dyes and use selected direct dyes which dye both the fibres almost equally avoiding high temperature and alkaline bath. The sequence of operations for dye an old faded garment may be as follows: Thoroughly check the garment turning the pockets inside out to dry/brush to remove as much dirt as possible and also anything left in pockets such as tobacco, grains etc. than scour the garment in the bath at 30-40ºC with some non-ionic detergent (2-5%) and ammonia (3%), rinse and dye at 80-85 ºC, keeping the pH 6.5-7.0 for 30 min in the bath containing the dye and Glaubers salt (20-40%). If faded portions come out lighter, than dyeing is continued for 30 min more and if still lighter then only some neutral dyeing acid dyeing (tone to tone) may be added to equalize the faded portion. Wool/cotton can be similar dyed by the use of acid dyes for wool and direct dyes on cotton at higher pH and control of temperature.

CONCLUSIONS

A wool/ cotton-blend fabric is ideal for multiseason apparel because wool provides inherent resiliency and warmth while cotton contributes comfort and coolness. These textile treatments may broaden the market for cool-weather garments made of cotton/wool blends. In sweaters, for example, the blend's wool component retains body heat and imparts thickness, while cotton makes it comfortable to wear. Both natural fibers are great at wicking away moisture. However, their spinning, finishing, dyeing requires special technique, machinery and critical control of the process.

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